Recent Imaging Results from SINGS

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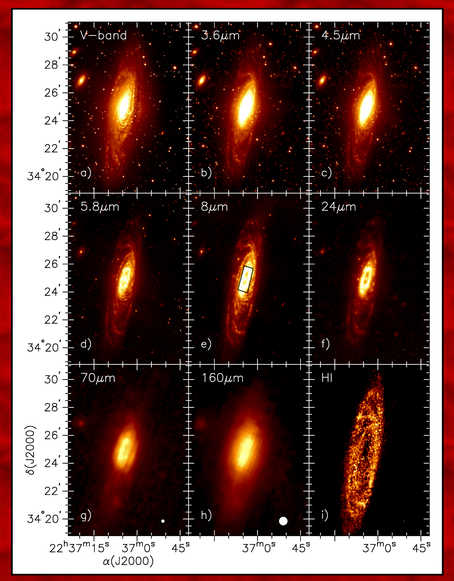
Abstract

The Spitzer Infrared Nearby Galaxy Survey (SINGS) is a comprehensive infrared imaging and spectroscopic survey of 75 nearby galaxies. One of the primary goals of SINGS is to compare star-formation rates derived from far-infrared emission with rates derived from other generally accepted star-formation indicators, specifically ultraviolet emission, Hα emission, and radio synchrotron emission. A related secondary goal is the search for other emission mechanisms, such as mid-infrared PAH emission, that may correlate with these star-formation indicators. Further study of these star-formation tracers will give us better understanding of the physical processes that link them all together. We present recent results from SINGS observations of NGC 7331 and M81 that relate to this work, and we also show some of the IRAC and MIPS images recently obtained by SINGS.

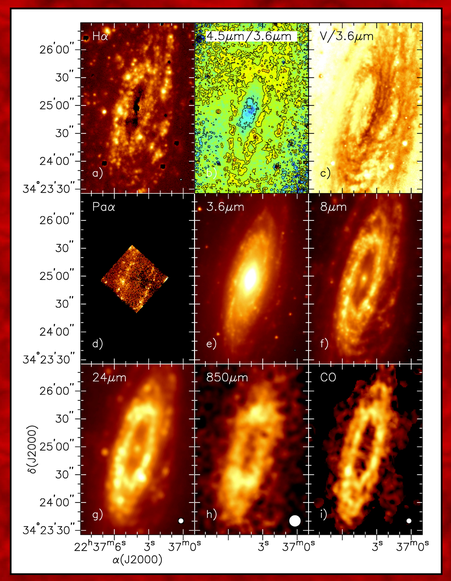
Recent Results: NGC 7331

These results appear in M. Regan et al. 2004 ApJS 154, 204. The images presented in the paper illustrate the qualitative correspondence between the many tracers of star formation in this galaxies. Hα and Paα recombination line emission, 5.8 and 8.0 μm PAH emission, dust emission from 24 to 850 μm, CO millimeter line emission, and HI 21 cm line emission are all found to trace similar star formation structures in the disk and in the central starburst ring. Meanwhile, the 3.6 and 4.5 μm bands function as good extinction-free tracers of the stellar mass.

The figures do illustrate some of the problems with some tracers of star formation. For example, note the dust extinction seen on the right side of the inner ring in the Hα image. This demonstrates why the cross-calibration of star formation tracers is necessary.



The above figures are global maps of NGC 7331 in different wavebands. Note how the 5.8 and 8.0 μm PAH emission, the 24 – 160 μm dust emission, and the HI line emission all trace similar star formation structures in the disk, which suggests that PAH emission, dust emission, and atomic gas density are related.



The above figures are images of the starburst ring in the center of NGC 7331 as seen in different wavebands. The Hα and Paα line emission, 8 μm PAH emission, 24 μm hot dust emission, 850 μm cold dust emission, and CO line emission all trace star formation in the ring, but the Hα emission is affected by the dust extinction (which can be seen in the V/3.6 μm image).

Recent Results: M 81

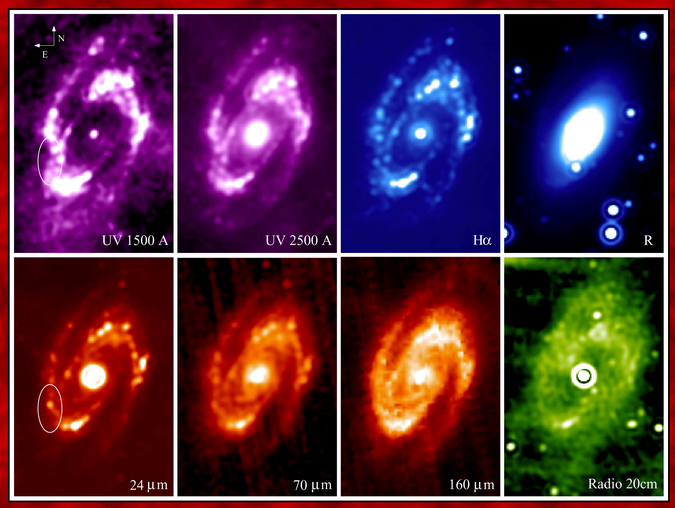
These results appear in K. Gordon et al. 2004 ApJS 154, 215. The paper qualitatively and quantitatively compared star formation tracers in M81.

In the nucleus, in selected HII regions in the arms, and in the interarm regions, star formation rates derived from ultraviolet and Hα data were found to be significantly lower than star formation rates derived from infrared fluxes. Three factors could have led to the mismatch:

1.The ultraviolet and Hα fluxes are affected by dust extinction.

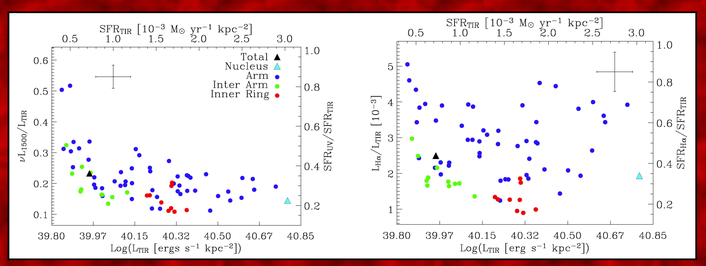
2.Some of the dust emission may not be related to star formation activity, although the concentration of 160 μm emission in the spiral arms implies that even the cooler dust emission is associated with star formation.

3.The luminosity – SFR calibration factors applied in this paper are simply inappropriate for individual regions within a galaxy.



The figure on the left shows images of M81 in ultraviolet, Hα, infrared, and radio bands, all convolved to the resolution of the MIPS 160 μm band. All of these bands are considered tracers of star formation activity. Note that they all qualitatively trace similar star formation structures, particularly in the spiral arms, although the affects of dust extinction are still evident (note the region in the ellipse in the ultraviolet and 24 μm images).

Also note the radically different appearance of the R-band image, which traces starlight.

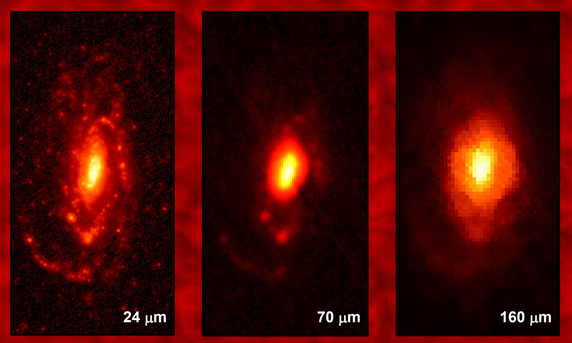


The plots to the right compare UV/IR and Hα/IR colors to IR luminosities. As can be seen in the figures, these figures suggest that the ultraviolet and Hα star formation tracers measure lower star formation rates than infrared fluxes.

Newly Processed Data: M51

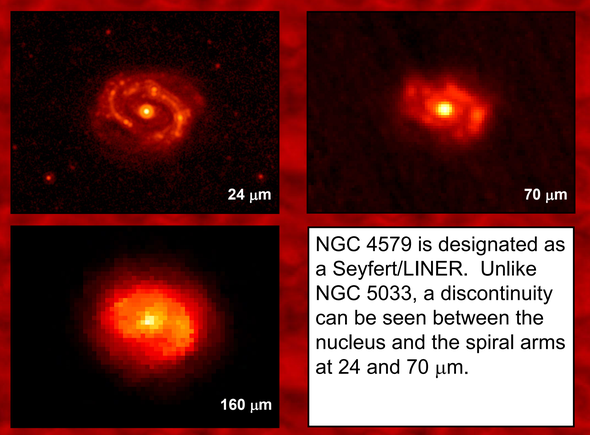
M51 is a famous pair of interacting galaxies. The 3.6 and 4.5 μm images of these galaxies trace the stars in these galaxies, the 5.8 and 8.0 μm images trace the PAH emission, and the 24 – 160 μm images trace the dust emission. Note how the PAH and dust emission are associated with similar star formation structures in the disk. Also note the tidal tail visible in the PAH emission from the dwarf galaxy.

Newly Processed Data: NGC 5033



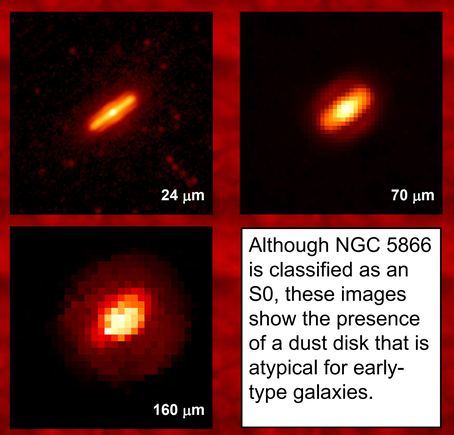
NGC 5033 is a late-type Seyfert galaxy. Note the strong dust emission from near the nucleus.

Newly Processed Data: NGC 4579



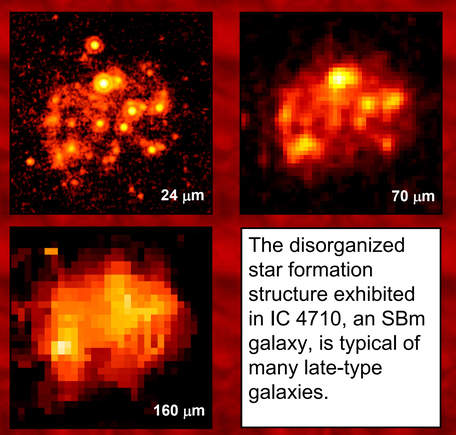
NGC 4579 is designated as a Seyfert/LINER. Unlike NGC 5033, a discontinuity can be seen between the nucleus and the spiral arms at 24 and 70 μm.

Newly Processed Data: NGC 5866



Although NGC 5866 is classified as an S0, these images show the presence of a dust disk that is atypical for early-type galaxies.

Newly Processed Data: IC 4710



The disorganized star formation structure exhibited in IC 4710, an SBm galaxy, is typical of many late-type galaxies.